The Colorist

J·A·H·HATT


So very, very
true, and so
very, very
pretty.
Just as
pictured.

THE COLORIST

DESIGNED TO CORRECT THE COMMONLY HELD THEORY THAT RED, YELLOW, AND BLUE ARE THE *PRIMARY* COLORS, AND TO SUPPLY THE MUCH NEEDED EASY METHOD OF DETERMINING COLOR HARMONY

TOGETHER WITH

A SYSTEM OF COLOR NOMENCLATURE AND OTHER PRACTICAL INFORMATION FOR ARTISTS AND WORKERS OR DESIGNERS IN COLORS

BY

J. ARTHUR H. HATT

THIRD EDITION

NEW YORK
D. VAN NOSTRAND COMPANY
EIGHT WARREN STREET
1925

TO

Mr. John D. Morgan

THIS BOOK IS DEDICATED

BY THE AUTHOR

Preface to the First Edition

THAT there are very few practical works on color would seem to be a sufficient reason for the publication of a new one. When we add to this that the few now in existence contain comparatively little information based on the scientific principles of light, and color as a function of light, and contain consequently many misleading and contradictory statements, the publication of a work on color, which is based on the scientific principles of light and color, and presents a consistent theory of color based thereon, becomes a necessity.

About fifty-five years ago, a French gentleman, M. E. Chevreul, a manufacturer of dyestuffs, made an extensive series of experiments with colors. He undoubtedly made a great contribution to the knowledge of colors, but not being as well grounded in the science of color as we are at the present time, he naturally made a large number of mistakes. These mistakes have been the heritage of the art world in all color literature since his time. We have no desire to detract from the deserved

renown of M. Chevreul, who is entitled to praise for a great amount of laborious and original work. We do wish, however, to emphasize the present need of a scientifically correct theory of color upon which a more exact and at the same time a more artistic practice may be based.

There are, it is true, some excellent scientific works on light and color. Unfortunately, however, the scientist is rarely a great authority on art, and rarely touches on those problems in color which the practical worker wishes to solve.

The object of this little book is to give precise data, whereby a color scheme may be analyzed, and beauty in color appreciated and produced. The book contains for the first time in color literature, either scientific or artistic, a complete unity between science and practice, as well as a concise and consistent law for color harmony and beauty in color, which the author confidently believes will stand the test of time and the fullest investigation.

Although this book is based on scientific principles, it is practical, as simple as possible, and may be understood by all classes of readers.

The author does not believe with many writers on the subject that it requires a genius to be a *colorist.* On the contrary he believes that it requires only a thorough knowledge of color. A superior aptitude for color will of course always produce a superior colorist, because the latitude for choice of color in good color composition

is so very large that the colorist with the best taste or talent will naturally do better than one not so well endowed. However, with a thorough knowledge of color no one need be a bad colorist.

While this work is intended and adapted for the general reader, with the belief that a more thorough knowledge of color on the part of the public would have a great stimulating effect on good art, it is intended especially for artists, art students, architects, color printers, decorators, and costume designers.

J. Arthur H. Hatt.

Brooklyn, N. Y., November 21, 1908.

Preface to the Second Edition

THE Author desires to express his gratification at the cordial recognition of the first edition of "The Colorist."

Many written and oral expressions of pleasure and congratulation have been received from readers of the book, all attesting to the helpfulness of the color charts, and the rational ideas of color harmony and beauty which the volume outlines.

The text of the present edition has been improved by the addition of a list of permanent colors, and methods for their use, to the chapter on "A Full Palette" (Chapter IX.)

The color plates, also have been enriched by the addition of two small examples of color combinations, one being an actual example of the "Subtractive Method," and the other a near representation of the "Additive Method".

J. A. H. H.

New York
June 2nd, 1913

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Contents

DIRECTIONS FOR DETERMINING A COLOR HARMONY WITH THE AID OF COLOR CHART (NO. 1)

IT WILL be observed that the main circle of the Color Chart is composed of the plus colors and the minus colors alternating, and separated by a blend of the nearest two colors in each case.

These colors merge from the saturated or full strength color at the outer edge of the circle to white at the center.

The three outer rings are produced by printing the three minus colors over each other in various strengths or degrees of saturation.

By fitting the mask * to the chart, which is done by centering it on the chart, and turning it until the desired colors show, we have perhaps the widest range of colors exposed which can be said to properly harmonize.

Artists may safely use all the colors exposed in this manner in a picture, with full confidence in securing a harmonious result.

For those who desire a more limited range of colors for any purpose, it will only be necessary to further mask

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* The mask will be found printed on one of the blank pages at the back of the book, and is to be cut out for use.

out colors not desired by placing strips of paper over the exposed portion of the chart and changing them about at will until a combination of colors is found that meets the taste or requirements of the user.

The matching of a color on the chart with another color or pigment can best be done by viewing the two colors through small holes cut in two sheets of white paper (or gray paper); the holes should be small enough to show only the desired color in each case.

It will be observed that the Harmony Chart (No. 1) does not contain any of the lighter tones of color, but on the contrary ranges from full tones of color to deep shades of color; where lighter tones or tints of color are desired in a combination, they may be observed by viewing the chart through very thin white tissue- or wax-paper.

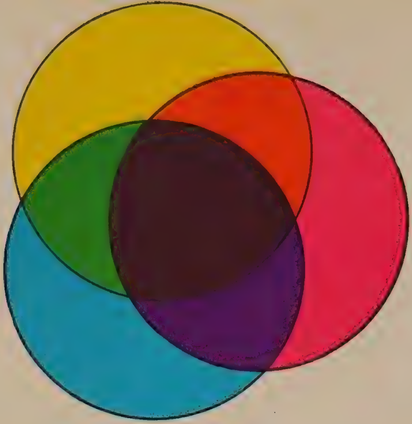
A mask will not be necessary when the chart is viewed in such a manner, as all the colors on the chart should harmonize when sufficiently reduced with white. For decorative purposes, however, or in cases where a more confined harmony would be desirable, the mask may be used in the usual way when viewing the chart through white tissue-paper.

A harmony of pure hues may be determined on the Nomenclature Chart (No. 2) by placing a mask over it so as to expose an arc of 75 degrees on the color ring. (This arc will contain five divisions of the colors.)

On the nomenclature chart it will be noticed that the hue named lemon yellow does not accord well with the hue

commonly recognized by that name. This is partly because the color generally known as lemon yellow is more or less a tint, that is, a full hue mixed with white; on the chart it is intended to show only full hues. Then again the art of printing does not readily lend itself to scientific accuracy, and the author will be pleased if the charts are only approximately correct.

Pure minus colors magenta and cyan blue are not at present obtainable in permanent pigments, therefore these charts should never be exposed to sunlight, and when not in use should be protected from all light. Treated in this way they will last for years unimpaired.



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By J. A. H. Hatt

Harmony Chart No. 1

An actual example of the Subtractive Method of Combining Colors.

This Chart together with the mask is designed for the purpose of determining color harmonies. See directions on preceding pages.

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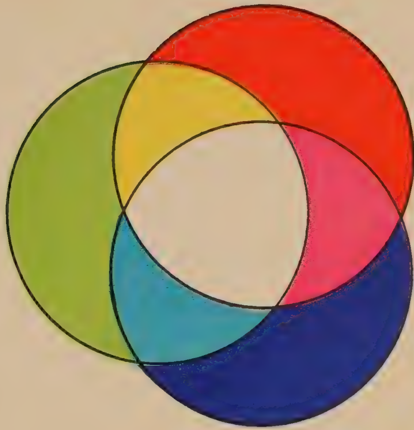
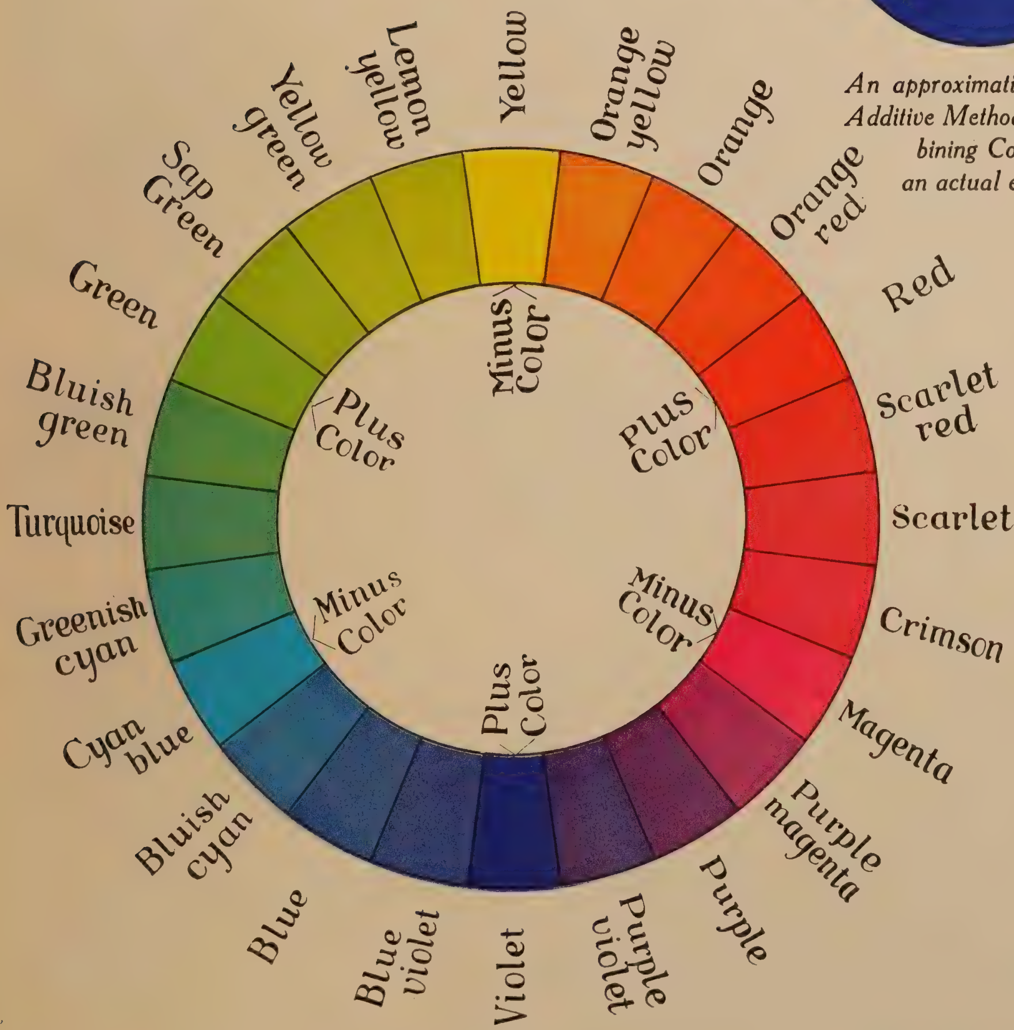
"The Colorist"

By J. A. H. Hatt

Nomenclature Chart No. 2



An approximation of the Additive Method of Combining Colors. (Not an actual example.)



Showing proposed names for hues 15° apart.
Colors opposite each other are complementary.

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THE COLORIST

CHAPTER I

LIGHT THE SOURCE OF COLOR

THAT the eye is enabled to see objects is due to the fact that objects reflect light which, entering the eye, excites the optic nerve, and through it, the brain. Light therefore is the agency which causes the sensation of sight and also of color through the nerves of the eye, which are sensitive to the light rays.

The accepted explanation for this phenomenon is that what we call or know as light rays are in reality a series of waves or agitations of the hypothetical ether, which pervades all space. The eye is constructed so as to be sensitive to these agitations when they impinge upon it, somewhat after the fashion of the focussing screen or ground glass in a camera behind the lens.

Colors are due to differences in the length and rapidity of vibration of these ether waves, those of one length and corresponding rapidity giving a different color sensa-

tion from those of a different length and rapidity of vibration. Where waves of different lengths are transmitted together, the color sensation will correspond to the resultant or additive combination of all the transmitted waves.

Light is commonly produced by incandescence, natural light being rays of sunlight, artificial light being produced by various incandescent materials. The intensity of the heat of the incandescent source, as well as the nature of the incandescent material, seems to be a determining factor as to its general color, the greatest temperature producing light rich in violet rays, the lesser temperature producing light with a larger amount of red rays.

Sunlight is a comparatively yellow light, or rich in red rays. This is not at all times so obvious because of the color of the atmosphere which, being blue, has a tendency to make the average of light which we perceive more nearly white.

The electric arc lamp often produces a bluish or violet light. Most of the common sources of light, such as candle-light, gas, oil, or incandescent electric lamps, produce a yellow light.

It may be pointed out that this tendency to yellow in artificial light may be corrected by allowing the light to pass through a bluish-colored glass, which should make the light more white.

Light may be either direct or diffused; direct when it is not interfered with in going from its source to an object illuminated, as a ray of gaslight falling on a near object,

or diffused when the light is interfered with, as sunlight on a cloudy day, or by reflection, as the daylight illumination of a room through a north window.

Light may be divided into various colors, as in the spectroscope (a prism of glass arranged in an optical instrument, the image in such instrument being called a spectrum), or by a laminated surface, such as mother-of-pearl. Colored objects have the property of dividing light by absorption. When we look at a red object which is illuminated with white light, the sensation of red is produced because the violet and green rays are absorbed by the object, and not reflected, leaving only the red rays to be reflected to the eye.

It will be seen on examining the image in a spectroscope (the spectrum) that light is divided into three natural or grand divisions, namely, *red*, *green*, and *violet*. A small band of yellow and of blue may also be observed in the spectrum. These may be accounted for by the overlapping of the red and green rays in the case of the yellow, and the overlapping of the green and violet rays in the case of the blue.

It is of course true that there are certain portions of the yellow in a pure spectrum which we are not able to divide into the red and green elements. The fact remains, however, that we can make all hues of yellow by overlapping the red and green. The above remarks also apply to the blue.

The red waves are regarded as being the longest, and the

violet waves the shortest. The lengths of light waves are said to vary from 750 to 400 million parts of a millimeter.

If under white light an object appears white, this is due to its reflecting all light; if it appears black, it is due to its absorbing all the light, and consequently reflecting none. If it absorbs some of the light rays or waves, it will appear of the color corresponding to the remaining rays or waves which are reflected back to the eye of the observer.

The foregoing on the general theory of light is not complete or strictly accurate from a scientific standpoint, but is regarded as a preferable and sufficient preliminary presentation for the purposes of this work.

With a medium amount of illumination, the red and violet colors of the ordinary spectrum may be considered as representative or standard. This is not the case, however, with the green color of the spectrum, which is to a slight degree diluted with white. The green color may be considered nearly correct as to hue, but deficient in power or lacking in strength, and slightly tinged with yellow. This deficiency in the color of the green of the ordinary spectrum is probably caused by a slight overlapping or diffusion of a greater amount of the red rays on one side and a smaller amount of the violet rays on the other side.

An excess of illumination has a tendency to make a number of changes in the colors of the spectrum, such as making the violet more blue, the green more yellow, and the red also becomes more yellow when thus illuminated.

For this reason the normal spectrum may be seen best with a medium illumination.

Only a small proportion of the ether waves or undulations is visible to the eye. Some of these waves are too long or too slow, as those of the infra-red, while others are too short or too rapid, as those of the ultra-violet.

This may be demonstrated with an electric arc lamp rich in violet rays, by cutting out the red and green rays entirely, and a large proportion of the bluish-violet rays; this may be done with a strong violet-ray filter used in connection with a very pale-yellow filter. Now by observing the remaining violet light through a solution of sulphate of quinine, which has the property of slowing down or lengthening the light rays or waves, we will perceive a much brighter violet than is the case when viewing the light without the intervention of the sulphate of quinine. This proves that when the ultra-violet rays are slowed down or lengthened, they become visible. We shall treat only of the visible rays in this book.

The eye is supposed to be supplied with three sets of nerves, each more responsive to the action of one of the grand divisions of light than to the others. Thus, one set is acted upon mostly by the red rays, another set by the green rays, and another set by the violet rays, the combined action of all the rays producing the sensation of white light.

The luminosity or brilliancy of the light has a great deal to do with the extended color action of the eye nerves.

For instance, in a normal or weak reflected light it is possible that each color nerve is acted upon by only its own selective color.

A wave action confined to only one of the sets of nerves would obviously produce the sensation of color that that particular set of nerves was sensitive to; likewise, the wave action on two sets of nerves will produce the sensation of the mixture of those two rays; for example, when the red sensitive and the green sensitive nerves are acted upon simultaneously, the sensation of yellow is produced, which is the resulting mixture of those two light rays.

It is evident that the eye is primarily designed or constructed for seeing white light, from the fact that when less than the three nerves are acted on at one time, the nerves so acted on become fatigued. This can be demonstrated by the following experiment. Place on a well-illuminated sheet of white paper a small patch of brilliant color, say red. After having allowed the eye to rest by closing the eyelids for twenty seconds or more, allow it to observe the color patch for a similar length of time. After having observed the color patch for a sufficient length of time, transfer the gaze quickly to another part of the paper, or quickly remove the color patch. There will now be observed in place of the red color patch, a similar form, but of a complementary color (blue).

One explanation for this is that the color of the patch has fatigued the eye nerves which respond to its color, and when the gaze is transferred to the white paper, the com-

plementary color nerves to that of the color patch, not having been fatigued, respond more freely to the action of the white light reflected from the paper, thereby having the effect of tinting it with the complementary color of the patch, or producing a **negative image**.

Another explanation is that this fatiguing action of the eye nerves has the property of calling up a sympathetic action of the nerves not acted on. This latter explanation gathers weight from the fact that the negative image so produced will have a more marked effect on a black surface than on a white one.

The color of a so-called negative image of a

Blue	color	is	pale red.
Green	"	"	light pink.
Magenta	"	"	light green.
Yellow	"	"	faint violet.
Violet	"	"	pale yellow.
Red	"	"	greenish blue.

On account of this peculiarity of the eye, the painter who wishes to fully appreciate the brilliancy of the hue or color he is working with must needs rest the eye frequently by looking at a color complementary to that with which he is working.

This fact of the eye being fatigued, or having the property of calling up a negative image, plays an important part in the appearance of colors when placed beside each other, or juxtaposed, one color through the medium of the

eye having an influence on and changing the aspect of the other.

This law may be expressed as follows:

When two dissimilar colors (hues, tones, tints, or shades) are juxtaposed, their dissimilarity is accentuated.

If we consider white and black to be complementary, in the sense that blue and red or green and magenta are complementary, then we may say that the effect of juxtaposing two dissimilar colors or tones is to tint each with the complementary color of the other.

For example, juxtaposing white and black has the effect of making the black blacker and the white whiter. Juxtaposing a light gray and a dark gray has the same effect. Juxtaposing a green and a magenta has the effect of brightening both of the colors, as they are complementaries.

Juxtaposing a blue and a gray has the effect of tinting the gray with a pale red, while the blue has the appearance of being lighter or darker, depending on the depth of the gray.

Juxtaposing a yellow and a red has the effect of tinting the red with violet, making it more crimson, and of tinting the yellow with blue, making it more green.

CHAPTER II

THE OLD IDEA OF PRIMARY COLORS

THE theory known as the "Brewster" theory, that *Red*, *Blue*, and *Yellow* are the primary colors, probably goes as far back in antiquity as any artistic color knowledge. The ancient Greeks had a palette of red, blue, yellow, white, and black, and probably green.

According to this theory,

The primary colors were....................	*Red*, *Blue*, *Yellow*.
The secondary colors were..................	*Orange*, *Green*, *Purple*.
The tertiaries were mixtures of all three in varying proportions..........................	*Russet*, *Slate*, *Citrene*.

According to this theory a green color was such because it was supposed to consist of yellow and blue. This is essentially incorrect, as in reality blue and yellow both contain green.

With this old theory artists and experts found it difficult to locate the exact hue of red, yellow, or blue which could be considered the respective exact or fundamental hues of pure colors. Their yellows inclined too much towards either green or orange. This is easily accounted for when we consider that yellow is composed of green and red rays, and even a greenish yellow has red rays to reflect to the eye.

They could not decide on the proper blue because the blues contained either too much green or too much violet. Blue is composed of green and violet rays.

Then again they could not account for the fact that a mixture of all three pigments did not produce white, as they supposed it should. It will be seen later on in this book that this should not be the case, and that pigment colors behave in every instance in accordance with scientific laws.

This old theory of primary colors does not fit the scientific facts as ascertained in modern times, and has been the cause of most of the misconceptions generally held by practical workers in colors.

Another misleading proposition generally taught in schools was that all colors could be found in the spectrum. As a matter of fact all colors are not found in the spectrum, a notable exception being magenta, a kind of crimson or purple pink, one of the primary colors of the subtractive set.

It is within present memory that the Newtonian "Seven Steps" of color were taught our students, giving the impres-

sion that they were distinctively principal or representative colors. These colors were given as *red, orange, yellow, green, blue, indigo,* and *violet.*

The orange and indigo are not principal or representative colors, while crimson pink, or magenta, which does not appear on the list, is representative or fundamental.

The orange may be mixed by the subtractive method with two parts of yellow and one part of magenta. The indigo color may be mixed with varying proportions of green and violet additively.

Another very prevalent error caused by the old theory of primary colors is that green and red are complementary or contrasting colors. On the contrary an orange red and a yellowish green actually make a most pleasing harmony.

A magenta and a pure green are contrasting colors; the magenta, however, should not be called a red, but rather a red purple.

CHAPTER III

THE SCIENTIFIC PRIMARY COLORS

HAVING in view the fact that light, as far as human vision is concerned, naturally divides into *red, green,* and *violet,* and that the nerves of the eye are undoubtedly arranged to correspond or harmonize therewith, and that no other logical explanation will account for the various color phenomena, we can definitely decide that the true primary colors, the sources of all other colors, are *red, green,* and *violet.*

It is probable that what we call a primary color is such only in relation to the organ of sight, the eye, and has no such function with light itself independently.

The points at which the spectrum represents the fundamental color sensations, according to Clerk-Maxwell, are: *Red,* $\frac{1}{3}$ the distance from *C* towards *D*; *Green,* $\frac{1}{4}$ the distance from *E* towards *F*; and *Violet,* midway between *F* and *G.*

These colors may be roughly represented by a scarlet red, emerald green, and a good artificial ultramarine blue.

There being three methods of mixing or combining

colors, two perfect methods, and one imperfect method, there are also two sets of colors capable of producing all other colors by combining or mixing by one or the other method. These methods of mixing or combining colors may be named the *additive* method, the *juxtaposit* method, and the *subtractive* method.

The additive method is used when we combine colored rays of light to produce a picture or combination of colors, as with the photochromoscope. The red, green, and violet set of colors, called the plus colors, are used as the primary colors with the additive method.

The subtractive method is used to combine colors by superposition of pigments, as in printing or lithographing. This is done by superposing the *Yellow, Magenta,* and *Cyan Blue* primaries, called the minus colors. The minus colors are complementary to the plus colors as follows:

Plus Colors.		Minus Colors.
(Scarlet vermilion) *red*. . . .	complementary to	*cyan blue*.
Green.	"	" *magenta*.
(Bluish) *violet*.	"	" *yellow* (slightly orange).

The juxtaposit (imperfect) method is used largely in the various methods of painting and in the new method of color photography brought out by M. M. Lumière of France (in which the "Autochrome" dry plate is used), also in the Joly and McDonough methods of color photography.

By the juxtaposit method the colors are blended or mixed by being placed side by side.

The *Red*, *Green*, and *Violet* primaries, or plus colors, may be used to compound all other colors when used as rays of light, which constitutes the additive method of combining colors. For instance, if a ray of red and a ray of green light are projected onto the same white surface, that surface will appear to be yellow. Combining a ray of green and a ray of violet light will produce a blue color. Combining a ray of red and a ray of violet light will produce a crimson-pink color, or magenta.

In other words the additive combination of any two of the plus colors will produce the complementary of the third (plus) color in the minus set of primary colors. Similarily, the combination of any two of the minus colors by superposition (subtractively) will produce the complementary of the remaining minus color in the plus set of primary colors.

Printing a transparent magenta over an orange yellow on a sheet of white paper will produce a red color. Printing blue over yellow will produce green. Printing blue over magenta will produce violet. The same thing may be done in oil colors by glazing one of the minus colors over another.

As a working hypothesis not, however, strictly accurate scientifically, one may assume that the ordinary white light is composed approximately of

$$\tfrac{1}{3}\text{ Red} + \tfrac{1}{3}\text{ Green} + \tfrac{1}{3}\text{ Violet.}$$

The plus colors therefore may be said to each represent $\frac{1}{3}$ of white light.

$$\text{Plus colors: }\begin{cases}\text{Red, } \frac{1}{3}\\ \text{Green, } \frac{1}{3}\\ \text{Violet, } \frac{1}{3}\end{cases}$$
$$\overline{\text{White, } \tfrac{3}{3}}$$

The minus colors may be said to each contain $\frac{2}{3}$ of the elements of white light as follows:

$$\text{Minus colors: }\begin{cases}\text{Yellow} = \frac{1}{3}\text{ Green} + \frac{1}{3}\text{ Red or } \frac{2}{3}\text{ White.}\\ \text{Magenta} = \frac{1}{3}\text{ Violet} + \frac{1}{3}\text{ Red or } \frac{2}{3}\text{ White.}\\ \text{C. blue} = \frac{1}{3}\text{ Violet} + \frac{1}{3}\text{ Green or } \frac{2}{3}\text{ White.}\end{cases}$$

Gray may be represented as follows:

$$\text{Red } \tfrac{1}{6} + \text{Green } \tfrac{1}{6} + \text{Violet } \tfrac{1}{6} = \tfrac{1}{2}\text{ White.}$$

The combination of cyan blue and yellow by the subtractive method, that is, by superposing them as transparent pigments, may be represented in figures as follows:

$$\left.\begin{matrix}\frac{1}{3}\text{ R.}\\ \frac{1}{3}\text{ G.}\end{matrix}\right\} = \tfrac{2}{3}\text{ Yellow} + \left\{\begin{matrix}\frac{1}{3}\text{ G.}\\ \frac{1}{3}\text{ V.}\end{matrix}\right\} = \tfrac{2}{3}\text{ Blue,}$$

or $$\tfrac{2}{3}\text{ Green} + \tfrac{1}{3}\text{ Red} + \tfrac{1}{3}\text{ Violet.}$$

The $\frac{1}{3}$ Red and $\frac{1}{3}$ Violet in this combination absorb each other, producing what may be called $\frac{1}{3}$ Dark (or Black). The $\frac{1}{3}$ Dark in turn has the property of absorbing $\frac{1}{3}$ of the

Green, leaving as a net result $\frac{1}{3}$ Green, the normal plus color. Or again, showing the method of cancelation:

$$\left.\begin{array}{l}\frac{1}{3}\ \text{R.}\\ \frac{1}{3}\ \text{G.}\end{array}\right\} = \text{Y.} + \left\{\begin{array}{l}\frac{1}{3}\ \text{G.}\\ \frac{1}{3}\ \text{V}\end{array}\right\} \text{(Blue)} =$$

$$\tfrac{1}{3}\,\text{G.} + \tfrac{1}{3}\,\text{G.} + \cancel{\tfrac{1}{3}}\,\text{R.} + \cancel{\tfrac{1}{3}}\,\text{V.} = \cancel{\tfrac{1}{3}}\,\text{G.} + \tfrac{1}{3}\,\text{G.} + \cancel{\tfrac{1}{3}}\,\text{Dark} = \tfrac{1}{3}\ \text{Green.}$$

The combination of blue and yellow by the juxtaposit method as exemplified in using Maxwell discs on a color wheel, or placing the colors side by side in small particles, may be represented in figures as follows:

$$\left.\begin{array}{l}\frac{1}{3}\ \text{G.}\\ \frac{1}{3}\ \text{R.}\end{array}\right\} \text{(Yellow)} + \left\{\begin{array}{l}\frac{1}{3}\ \text{G.}\\ \frac{1}{3}\ \text{V.}\end{array}\right\} \text{(Blue).}$$

In the juxtaposit method, only one-half of the superficial area being covered by each color, this fact may be represented by dividing the above figures by 2 as follows:

$$\left.\begin{array}{l}\frac{1}{6}\ \text{G.}\\ \frac{1}{6}\ \text{R.}\end{array}\right\} \text{(Yellow)} + \left\{\begin{array}{l}\frac{1}{6}\ \text{G.}\\ \frac{1}{6}\ \text{V.}\end{array}\right\} \text{(Blue),}$$

or

$$\tfrac{1}{3}\ \text{G.} + \tfrac{1}{6}\ \text{R.} + \tfrac{1}{6}\ \text{V.}$$

This sum may be divided into gray and green as follows: Subtract from it $\frac{1}{6}$ R., $\frac{1}{6}$ G., $\frac{1}{6}$ V., which equals a gray, leaving a balance of $\frac{1}{6}$ Green. Therefore the juxtaposit method gives us $\frac{3}{6}$ Gray + $\frac{1}{6}$ Green, or a gray slightly tinted with green. This makes evident the fallacy of using the color wheel as a standard or guide for the indiscriminate

mixing of colors. It will be found that only those hues within 75 degrees of each other on color chart No. 2 can be combined on the color wheel to produce a result approximating that obtained by the subtractive method.

The combination of blue and yellow by the additive method may be represented as follows:

$$\left.\begin{matrix}\frac{1}{3}\text{ R.}\\ \frac{1}{3}\text{ G.}\end{matrix}\right\}\text{(Yellow)} + \left\{\begin{matrix}\frac{1}{3}\text{ G.}\\ \frac{1}{3}\text{ V.}\end{matrix}\right\}\text{(Blue)},$$

or

$$\tfrac{2}{3}\text{ G.} + \tfrac{1}{3}\text{ R.} + \tfrac{1}{3}\text{ V.}$$

As white is composed of $\frac{1}{3}$ G., $\frac{1}{3}$ R., $\frac{1}{3}$ V., we may divide the above sum into white + $\frac{1}{3}$ Green; therefore the additive method gives us a whitish green when combining blue and yellow.

The combination of green and red (plus colors) by the additive method may be represented by figures in the following manner: ($\frac{1}{3}$) Green + ($\frac{1}{3}$) Red = ($\frac{2}{3}$) normal Yellow.

The combination of the plus colors red and green subtractively may be represented in figures as follows:

Let white be represented by. . $\frac{1}{6}$G., $\cancel{\frac{1}{6}}$G., $\frac{1}{6}$R., $\cancel{\frac{1}{6}}$R., $\cancel{\frac{1}{6}}$V., $\cancel{\frac{1}{6}}$V.

Subtract from it by cancelation. $\cancel{\frac{1}{6}}$R., $\cancel{\frac{1}{6}}$R., $\cancel{\frac{1}{6}}$G., $\cancel{\frac{1}{6}}$G. (representing the red and green).

Resulting in. . . $\frac{1}{6}$ G., $\frac{1}{6}$ R. + $\frac{4}{6}$ Dark, equaling a yellowish black.

The above computation is based on the fact that both red and green absorb violet and absorb each other when

combined subtractively. We have then accordingly four cancelations, each producing an element of dark, and the $\frac{1}{6}$ G. and $\frac{1}{6}$ R. remaining forms a gray yellow which, added to the four elements of dark, will produce the above result —a yellowish black.

CHAPTER IV

THE ADDITIVE METHOD OF COMBINING COLORS

AS PREVIOUSLY stated, the plus colors are used for combining colors when the additive method is used. There are two practical processes for using this method, both of which were invented by Mr. F. E. Ives.

One of these is connected with the use of the photochromoscope, or, as Mr. Ives calls his invention, the "Kromskop." In this instrument three photographic positives, made from what may be called three three-color negatives, are placed so as to reflect a single combined image to the eye. The light which passes through each positive is filtered through a colored glass which corresponds with the color of the screen or filter through which the negative was made. The colors of these glasses are respectively red, green, and violet, i.e., the plus colors.

By an ingenious arrangement of transparent mirrors, these separate images are made to combine in the eyepiece

of the instrument, and present a complete picture to the observer.

The other invention of Mr. Ives is the triple-projection lantern, in which three colored rays of light are thrown onto a screen in register. All of these colored rays of light are modified, and the gradations and blacks are supplied with a positive, as in the Kromskop. With both of these instruments approximately perfect results may be obtained.

On looking through a properly adjusted kromskop, without the positives being placed in it, *white* will be observed; this is produced by the union of all three colors. By obstructing the light from the red glass, the color in the instrument will be blue, the combination of the green and violet.

In the same way by obstructing the light from the green glass, magenta will appear, being the result of combining red and violet. Obstructing the light from the violet glass, we get the combination of the green and red, which is yellow. These same experiments may be carried out with the triple-projection lantern.

With the additive method of combining colors, *white* is produced, and when blacks and grays are required, they must be supplied independently. This is done with these two instruments by interposing a photographic positive, so as to partially obstruct the light from each of the colors.

It will be noted that the plus colors being the source

of all colors, so far as human vision is concerned, they are in fact elementary, and contain only one element of white light each.

The minus colors being made up of pairs of the plus colors, each contain two elements of white light.

CHAPTER V

THE SUBTRACTIVE METHOD OF COMBINING COLORS WITH PIGMENTS

THE minus colors are used for combining colors by the subtractive method. They are:

Yellow, Magenta, and *Cyan Blue.*

Probably the most practical way to combine the minus colors so as to secure the full benefit of each color is the method commonly known as the three-color-printing process.

While with the additive method it is necessary to supply the black independently of the colors, with the subtractive method the opposite is the case, and the white must be supplied independently.

In other words the colors with the additive method will make white, but not black; the contrary is the case with the subtractive method, which will make black, but not white.

With the three-color-printing process the white is of course supplied by the paper on which the combination of colors is printed.

The great difference between the minus colors and the plus colors, which will be more fully brought out in our consideration of the subtractive and juxtaposit methods, is that the minus colors in each instance contain two of the elements of white light, while the plus colors contain but one. This will be clear from the following:

Red	is	one	element	of	*white*	light.
Green	"	"	"	"	"	"
Violet	"	"	"	"	"	"

Yellow contains two elements of *white* light—red and green.

Magenta contains two elements of *white* light—red and violet.

Cyan blue contains two elements of *white* light—violet and green.

Therefore when we print yellow on a sheet of white paper, we are absorbing but one ray of white light, namely, the violet, and reflecting the two rays,—red and green, to the eye. If we print a magenta over the yellow, we will then have absorbed or subtracted the green in the yellow, and a red will be the result. By printing cyan blue over the combination of magenta and yellow (red), we will then absorb or subtract the red or remaining light element, and black will be the result.

Another difference between the plus and the minus colors is that the plus colors have the property of absorbing two elements of white light, while the minus colors

have the property of absorbing but one element of white light, thus:

Plus Color.		Remaining Elements of Light.
Red	has the power of absorbing	green and violet.
Green	" " " " "	red and violet.
Violet	" " " " "	red and green.

For this reason we may produce black by printing a plus color over a minus color or, *vice versa*, a minus color over a plus color. Thus we may produce black by printing violet over yellow, or the reverse, because yellow absorbs one element of light (violet), and violet absorbs two elements of light, red and green (that is, yellow).

Minus Color.		Remaining Element of Light.
Yellow	has the power of absorbing	violet.
Magenta	" " " " "	green.
Cyan blue	" " " " "	red.

From the foregoing we can readily realize that the plus colors and the minus colors are what may be called complementary to each other, thus:

Plus Color.		Minus Color.
Red	is complementary to	cyan blue.
Green	" " "	magenta.
Violet	" " "	yellow.

Note.—It will be understood, of course, that in superposing colors subtractively, the covering color must be transparent, so as to allow the underneath color to exer-

cise its full absorbing power on the light of illumination. From the above it will be seen that printing yellow on white equals white minus violet; printing cyan blue on yellow subtracts the red from the yellow, leaving only the green element; superposing the magenta on the green has the effect of absorbing the green or remaining element.

In other words, white minus violet minus red minus green equals black. White has, of course, the property of reflecting all colors to the eye, while black reflects practically none.

Again, to superpose magenta and cyan blue on white, we get the following: White minus green (magenta) minus red (cyan blue) equals violet.

To superpose the plus colors subtractively, as in the three-color-printing process, black will result the same as with the minus colors, by reason of the complete absorption of the light elements. On the other hand, to project the three minus colors additively, as rays of light on the same white surface, white will result the same as with the plus colors, as all of the light sensitive nerves of the eye will be acted on simultaneously. However, by superposing any two of the plus colors subtractively, we do not get a pure color, but a color mixed with black or gray.

By superposing two of the minus colors additively, say yellow and magenta, we do not get a pure color, but a color mixed with white, a light or whitish red.

It will be remembered that the eye is supposed to be constructed with three sets of nerves sensitive respectively

to the plus colors red, green, and violet. And when two of the plus colors are superposed subtractively, a larger proportion of the elements of white light is absorbed or subtracted, and not allowed to act on the sensitive nerves of the eye; this leaves a relatively smaller amount of light rays to act than would be the case were the minus colors to be used the same way. For example, when two of the minus colors are superposed subtractively, say yellow and magenta, the green half of the yellow is absorbed by the magenta, while the violet half of the magenta is absorbed by the yellow, each color absorbing what may be called one-quarter of the total light of illumination, making in all one-half the light only, as compared with two-thirds of the total light in case of the plus colors superposed the same way.

Hence the difference in purity of color between the two compounds superposed subtractively must be in favor of the minus set of primary colors.

The same reason which makes for purity of color in the minus set when superposed subtractively, also causes a weakening or dilution of color when these colors are superposed additively. Each minus color being composed of two elemental rays of light, when they are combined additively, an excess of white light is introduced into the mixture. This of course is not the case with the plus colors, as has been explained.

Another feature of the difference between the additive and the subtractive method of combining colors may

be noted, as, for instance, in making color record or separation negatives for the additive and subtractive methods (kromskop and three-color-printing process), the same character of negative is not best suited for both methods. Good results in the kromskop may be secured only by the "color-curve" system of color separation. In the three-color-printing process the "pure-color" system of photographic color division gives the best results. In the "color-curve" system the negative plates are made sensitive to a wider area of the spectrum; in fact the sensitive regions on the different negatives merge into each other on the spectrum. In the "pure-color" system the zone of sensitiveness for each color is more confined and does not overlap, as with the other system.

An explanation of why this should be so will occur to the reader, when it is remembered that in the kromskop a composite or color picture is formed by *three* rays of *light*, while on a three-color print, with the usual method of observation by reflected light, we have at all times but one volume of illumination. We will also observe on mixing or producing a color with two elements in the kromskop, such as any of the minus colors, that we do not obtain a saturated or full power color, but instead we get a color diluted with white. In other words, viewing a picture in the kromskop is practically viewing it in an abnormal or excess of light, as compared with the ordinary methods of viewing colored pictures.

This peculiarity is taken care of in the "curve" system of photography by the extension of the sensitive area, as compared with the "pure-color" system. This extension of the area or overlapping of the colors has the effect in the kromskop of interposing a partial obstruction of the light in each element required for the mixtures, and in the three-color process, of too great an overlapping of the colors, giving a gray or flat result.

On the other hand, with the pure-color method of photography in which the color sensitive areas on the photographic plate are not allowed to overlap, but are arranged so that the sensitive area for each color ends where the next color begins, it is possible to get a more perfect division of the colors for the three-color-printing process (the subtractive method). This method of separating the colors would, however, not be satisfactory for the kromskop (the additive method), as the combined picture so made would be deficient in grays, and the colors formed in the instrument by the various combinations (the minus colors) would be too much reduced with white.

CHAPTER VI

THE JUXTAPOSIT METHOD WITH BOTH LIGHT AND PIGMENTS

IN THE previous chapters we have discussed methods of combining where the colors were transparent and allowed to exercise their absorbing power over the whole area of the combination when superposed.

The pigments ordinarily used by the artist, painter, lithographer, and printer are not as a rule sufficiently transparent to produce perfect results by the subtractive method.

The artist on his palette and the lithographer on his slab, when mixing colors for painting and printing respectively, do so more or less by the juxtaposit method, using the minus colors for primary or basic colors.

A good illustration of the juxtaposit method may be made as follows: Divide a two-inch-thick pack of white visiting cards in halves; paint the edge of one of the halves with vermilion, and the edges of the other half with a mixture of emerald green and gamboge; add just enough yellow to the green to make it a neutral or

spectrum green, and when dry, interleave the cards so that the edge of the pack will be in alternating colors.

If this pack of cards is placed under a weight and viewed from a little distance, it will appear to be of a dirty-yellow color, a yellow with a little gray added to it.

We can also do the experiment with a color wheel or an ordinary spinning top (a Maxwell color top). The top should have a flat upper surface and arranged so that two Maxwell discs may be attached thereto. Maxwell discs are made of paper of various colors, and are slit from center to circumference, so that when put together a part of the surface of each disc is exposed; they are joined at the slits by sliding them partly over and partly under each other.

Let one of these circles of paper be painted vermilion and the other spectral green, the same as the cards. When this wheel or top is rapidly revolved, the colors will appear to be transformed into a gray yellow, much like the color of the cards painted with similar colors.

Superposing the same colors by the additive method, a pure partially dilute yellow would be the result; superposing them by the subtractive method, a yellowish black or yellow brown would be the result.

The juxtaposit method is not a perfect method of combination when the result is viewed with only one volume of illumination, as it will not produce either a white or a black, it being necessary to supply both independently.

When we mix two opaque pigments, we are in effect arranging the particles of each color side by side and neither color has the opportunity of exercising its full absorbing power over the full area occupied by the mixture.

This statement applies of course only to pigments or colors that are opaque. To mix transparent pigments in the same way, a subtractive result is produced, because the colors over and under each other are each allowed to fully absorb the light of illumination.

Pigments in ordinary use are either partially opaque or partially transparent; hence the method of mixing them is usually between the subtractive and juxtaposit methods, depending on their relative transparency or opacity. For example, take powdered red and green, dry colors, and mix them, and a result similar to that of the color top is obtained, that is, a gray yellow. Take the same colors, have them transparent, ground in oil, and mix them together; the mixture will have a yellowish black or brown color, the same as though the colors were superposed subtract vely.

The new method of color photography devised by Lumière is based on the juxtaposit method. Though this method gives surprisingly good results, the results are not as perfect as those secured by Ives with the kromskop. This is because the juxtaposit method is not as perfect a method of combining colors as the additive method used in the kromskop. The process

is, however, simpler, and for this reason destined perhaps to more popularity than the Ives method.

Lumière supplies the tone scale or blacks with a photographic positive. He uses the plus colors (somewhat too much diluted with white) to produce the color values. This dilution with white makes it easier to simulate the white sensation than would be the case if the colors had their full value or power. The other aid in producing the sensation of white is that the pictures, being transparencies, are viewed by transmitted light. This method of viewing gives them the benefit of an excess or large volume of illumination, and has the tendency of making what would ordinarily be a gray, comparatively, look like white by a kind of optical illusion or contrast. Therefore we may say that the additive method requires three rays of light of illumination, the subtractive method requires one ray, reflected light, and the juxtaposit method to be at its best must have an excess or large volume of light of illumination, or we may say two rays, as compared with the others.

If a good three-color print be made transparent by waxing the paper or otherwise treating it, and is then viewed as a transparency, it will be found to be very weak in color. The blacks will appear gray and the colors diluted with white. This shows that only one volume of illumination should be used with the subtractive method.

When two volumes of light are used to combine colors by the juxtaposit method, as in the Lumière autochrome transparency, the plus colors are the proper or most desirable ones to use.

On the contrary, when the light consists of but one volume of illumination, as when viewed by reflected light, as is the case with a painting or print, the minus colors should be used in order to secure the best effects.

The combinations of color by the juxtaposit method, when viewed with two volumes of light, are much like those produced by the additive method, only lacking in power and brilliancy.

The juxtaposit method may be said to be a midway method combining some of the qualities of both the additive and subtractive methods. For instance, if we combine the plus colors by the juxtaposit method with one volume of illumination, we get a result approximating the additive result, with the addition of gray; and if we combine the minus colors in the same way, we get a result approximating the subtractive result, with the addition of gray or white.

At the risk of verbosity we append the following definitions:

An opaque color is one which will not reflect or transmit light from anywhere but the surface. Opaque colors usually have a brilliant appearance to the eye. Most colors that are transparent in thin layers are semi-transparent or translucent in thick masses, and look

dark or black by reflected light. The reason for this is that the light of illumination is permitted to enter the mass of color, but is interfered with on its return and not allowed to reflect back to the eye. The term transparent in this book is used only in a relative sense.

CHAPTER VII

BEAUTY IN COLOR

BEAUTY in color seems to depend largely on the taste of the beholder, and this taste is largely a matter of civilization.

The child or the savage prefers brilliant or glaring colors, while refined persons of mature years prefer colors more subdued.

The barbarian will fairly revel in violent or garish colors, and it must be confessed that the barbarian sometimes achieves wonderful results. On the other hand, a Corot will paint an admirable symphony in green grays, or a Whistler a beautiful combination of tinted grays.

The savage will decorate himself with glass beads and objects of brilliant colors, while civilized man contents himself with polished shoes as the only brilliant part of his attire.

In an esthetic sense beauty in color consists of harmony of hue, or of analogous colors combined more or less with a great or limited variety of tone.

In this book we shall use the word hue to mean vari-

ous pure colors not contaminated with white, black, or complementary colors.

Tones will represent colors modified with white and black, or white and a complementary color.

Tints will mean pure colors modified with white. Shades will mean pure colors modified with black.

In pictorial art harmony of hue combined with great variety of tone is mostly used in successful pictures.

In decorative art harmony of hue together with a limited variety of tone is considered in best taste.

Sartorial art is much like decorative art, though in it some license is taken with the laws of harmony in order to enhance the effect of the complexion, hair, or eyes, as the case may be.

Large areas of violently contrasting colors are in no sense beautiful.

Contrast and discord are synonymous in regard to color as well as sound.

Brilliant contrasts are only useful when they serve to accent a color composition, and should be used sparingly only for this purpose.

We will sometimes see in pictures with a most pleasing color composition good results attained by what appears to be the use of contrasting colors. At first glance this would seem to upset our theory of harmony. It, however, brings us to the consideration of another law governing the use of contrasting colors and harmonious colors.

This law relates to the amount of space or area occupied by the contrasting colors as compared to the harmonious colors.

A number of violently contrasting colors may be placed together in a harmonious composition, and a beautiful result will be attained if these colors occupy a relatively small space in proportion to the whole and are not too much scattered over the whole area.

In this manner we really get an added result of the whole of these contrasting colors, by the juxtaposit method, forming the equivalent of a mixture of an equal amount of opaque pigments, usually making a gray or broken color. This sum total gray or broken color is the real factor to be considered in the harmonious color scheme.

To illustrate this let us imagine a landscape made up of green-blue, green, and green-yellow colors, together with various tones of gray (harmony No. 11). These hues and tones should make a perfect harmony. Now let us introduce into the landscape, as accents, small figures clothed in vivid pinks, green, violets, yellows, blues, and reds. Let these figures be fairly small and well grouped, and the effect should be pleasing.

It is understood of course that the laws of aerial perspective must be observed in the introduction of the figures, which would give the natural effect of softening the colors.

A simple way to determine which colors harmonize

is to place the two sets of colors, the plus and the minus, in a circle, allowing the two sets to alternate 60 degrees apart. (See color chart No. 1.)

Begin by placing the yellow at the top and the violet at the bottom, place red next to the yellow on the right, and magenta between the red and the violet. On the other side place green next to the yellow and cyan blue between the green and the violet.

Beginning at the top and reading to the right, we will have the colors in the following order: yellow, red, magenta, violet, cyan blue, green. It will be observed that the contrasting colors are opposite each other, as yellow and violet, red and cyan blue, green and magenta. Now let us imagine that these colors gradually merge into each other. We may then regard as in complete harmony all colors that fall within an arc of 75 degrees.

We will find that the following general list of colors come within this range, and will in each case contain the hue elements of a harmonious color composition:

Harmony No. 1, yellow green to orange (inclusive).
2, yellow to red.
3, orange to scarlet.
4, red to magenta.
5, scarlet to purple.
6, magenta to violet.
7, purple to blue.

8, violet to cyan blue.
9, blue to turquoise blue.
10, cyan blue to green.
11, turquoise blue to yellow green.
12, green to yellow.

It will be understood of course that the author does not advocate the exclusive use of a two-color combination in plain bright or full hues. Such combinations could be improved by gently merging or blending the colors into each other, or of lowering the tone of one or both of the colors, preferably of both.

Varying to harmonious grays should be associated with all color combinations, either mixed, juxtaposed, or both, in order to produce the most pleasing results. The smaller the interval between the hues, the greater the need for their being associated, either by mixture or juxtaposition, with a greater variety of tones or grays, occasionally including even black and white.

It will be understood that tones of color will be included under the general name of gray as used above. This will include such tones as yellow and red browns, dark and light tones of green, and in fact the full range of tones of what were formerly distinguished as the "tertiary" colors, russet, citrene, and slate.

The above angle of division applies to pure colors or hues. These colors or hues, however, are seldom used in works of art of any description. The angle of divi-

sion may be enlarged as we lower the tone of the colors or dilute them with white. (We lower the tone by the addition of black, gray, or a complementary color.) Thus a low-toned green, yellow, and red will make a harmonious combination when comprising an angle of 90 degrees, instead of the angle of 75 degrees, of harmony No. 1.

It will be obvious that we may therefore continue to lower the tone and widen the angle until our zone of harmony will comprise the whole circle, and the colors will be a varied collection of grays or tones of color, or, with the admixture of white, a collection of varied tints of color such as we see in mother-of-pearl, or a combination of both.

The introduction of white and black into a color composition, to produce the most pleasing results, should be governed by the law of *variety*.

This law may be indicated as follows: The colors or hues being divided into two classes, namely, the luminous and somber, the luminous colors will comprise those extending from yellow green to yellow, red, and scarlet, inclusive, while the somber colors will include bluish cyan, blue, violet, and purple magenta. White, gray, and black are essentially of a tonal quality, and their association with colors being governed by the law of variety, white owing to its brightness will accord best with the somber colors, while black will give the most pleasing results with the luminous colors. Gray, being

neutral, associates well with both luminous and somber colors.

To fully appreciate the law of variety, one has only to contemplate the difference between a newspaper half-tone illustration, which is lacking in amount and variety of gradations, and a carbon print from a well-timed negative, or a well-done mezzogravure print. In both the latter the charm and beauty consist in their large variety of tones or gradations.

Besides the distinction of luminous and somber in colors, we also have the attributes of warm and cold, also advancing and retiring. Therefore the upper half of our circle may be variously denominated as *warm*, *luminous*, or *advancing*, while the lower half will be *cold*, *somber*, or *retiring*.

Colors may also be divided into *violent*, consisting for the most part of the pure, luminous, and bright colors, and *tranquil*, consisting of tonal or cold colors.

There is no doubt that civilized art finds expression in tranquil colors with large tonal variety, as compared with the violent colors and meager tonal effects of barbarous antiquity.

Chevreul, about fifty-five years ago, wrote a voluminous work on color and devised a system of color laws, which have been commonly accepted, without question, by writers on, and instructors in, color ever since.

Chevreul in common with all others, until very recent years, mistakenly adopted what is now known as the

''Brewster'' theory, namely, that *red*, *yellow*, and *blue* are the primary colors.

The colors generally selected as primaries by the followers of Brewster and Chevreul may be roughly stated as a yellow ranging from a pure chrome to a gamboge yellow. Scarlet red is fairly representative of the red. The blue could be anything from a pure ultramarine to a Prussian blue, the ultramarine blue enjoying the greatest popularity.

Now if we will examine the color chart No. 2, in which the colors have approximately their true relation to each other in regard to position on the circle, we will see that the yellow and the ultramarine blue are nearly 180 degrees apart, and the yellow and scarlet red about 60 degrees apart.

It is obvious that the true primary colors should be of an equal, or 120-degree, distance from each other on the circle. Having made the mistake of choosing the wrong colors for the primaries, Chevreul had to invent such inconsistent laws as ''Harmony of contrast'' of hues, colors, etc., to account for known beautiful harmonies.

A contrast cannot be a harmony; the two words are utterly at variance; it would be as well to say a harmony of discord.

These mistakes naturally led to such confusion as to make it difficult to realize that beauty in color is really amenable to very simple rules.

It may be well to state here that the minus colors advocated in this book as the primary colors for the subtractive method are primary in the sense that they cannot be duplicated or mixed subtractively by any other colors. This is of course true of the yellow advocated by Brewster. The Brewster scarlet red and ultramarine blue (violet) can be duplicated by very pure minus colors subtractively. This fact would be enough in itself to demonstrate that such selection of primary colors is erroneous.

We find, however, that when we place the principal colors in their relatively correct position in a circle that we are now able to determine with ease and certainty just which colors harmonize, and by using taste and judgment in making the selection for the particular object or use in view, it will be difficult indeed to make a mistake.

The reader is referred to the directions printed (for the better convenience of the user) on the page preceding the color chart No. 1, as to its use for determining color harmonies.

In reviewing the color laws formulated by Chevreul, the law known as "The harmony of scale produced by the simultaneous view of different tones of a single scale more or less approximating," the author wishes to state that the larger the variety of the tones of a single scale, the more beautiful the result must be. The "law" is therefore without point.

The law relating to "Harmony of hues" is in accord to a great extent with the principles advocated in this book.

The same may be said of the "Harmony of a dominant colored light."

Another law, known as "The harmony of contrast of scale produced by the simultaneous view of two tones of the same scale very distant from each other," conflicts with the first law cited, and is contradictory in itself.

A better substitute for both of these laws would be "The harmony of variety of scale (or tones) produced by viewing a large or a small variety of tones."

The laws "The harmony of contrast of hues" and "The harmony of contrast of colors" are probably the source of more errors in color harmony than any other known cause in the last half century. They are utterly at variance with truth.

It will be well to remember that the mixture of black and white produces a cold or bluish gray, and such a gray will naturally harmonize best with the cold colors, violets, blues, and greens. A gray to harmonize best with the warm colors should be warmer than the mixture of black and white.

Black is essentially a cold color, and when mixed with yellow has a tendency to produce a greenish shade, showing that it reflects more blue or violet light than any other.

This may be accounted for by likening the shorter wave lengths of the spectrum at the violet end to a heavy fly-wheel in motion, as compared with a light-weight wheel in motion, representing the longer waves of the spectrum at the red end.

In comparing the two classes of wheels it will be noted that it is more difficult to increase the motion speed of the heavy one than the light one; on the other hand the motion of the heavy wheel persists much longer than is the case with the light wheel. In a similar manner the violet and blue colors are never the brightest colors of the spectrum in a good light, and they are less affected by variations in the light of illumination than the others.

The reds and yellows, however, are very sensitive to variations in the light of illumination, as compared with the blues and violets. We find, therefore, that a blue or violet object is not as bright in a brilliant light as a red or yellow object, and we find also that the blue- or violet-colored object will retain its color less impaired, when subjected to a very weak light of illumination, than the red or yellow.

Black is usually represented by pigments or substances which reflect very little light, and it is natural to suppose, would reflect that part of the light which has the greatest inertia, that is, blue or violet, and to a lesser degree green.

It follows then that artists, in painting sunny land-

scapes, will keep their reds and yellows very bright and luminous. In evening or dimly illuminated scenes they will make the greatest alteration in the brightness of the reds and yellows, rather than the blues and violets.

CHAPTER VIII

HARMONY VERSUS CONTRAST OF COLOR

TO SAY that we have good grounds for believing that the color sense and an interest in color were developed in some of the earliest forms of life on this planet of ours, and that this development was the actual cause of the growth of color in many instances in the vegetable and animal kingdoms, would probably astonish some of our readers. It is now generally believed among scientists that the only terrestial colors in evidence before the development of any living organisms consisted, with few exceptions, of foliage green, dull yellow browns, representing decayed foliage, the grays of rocks, and the various dull yellow, red, and brown earth colors. None of these colors had, until comparatively recent or civilized times, any attractiveness for living organisms, and presented a somewhat monotonous appearance. With the advent of insect life, we next find the plants which depended on insects for the distribution of their fertilizing pollen, using color to attract insects to the store of sweets produced by the plants for

their allurement, and naturally the colors thus used would be brighter than the surrounding mass of greens and dull earthy colors.

The association of color, and gradually bright color, with food by these insects or animals obviously led to a liking for color on the part of the animals, and in consequence the plants displaying the brightest colors were better fertilized by the living creatures and were able to outgrow their rivals that displayed less brilliant colors.

It will be observed that the function of the bright color in the plant was not esthetic in its nature, but consisted only in the property of attracting attention from a distance, the animals meanwhile learning to associate the bright colors of Nature with food. This fact probably accounts for the taste of the child, savage, or barbarian for brilliant objects, the taste being inherited from our early progenitors who were accustomed to associate such objects with the food they gathered, whether it may have been honey from an attractive flower for the earliest form of insect life, or the various bright-colored fruits for prehistoric man. These bright colors of the plant life frequently consisted of colors that contrasted with their surroundings, contrasting colors having the property of attracting attention to a far greater degree than harmonious colors; and we will find at the present time that many of those plants or flowers which supply the sweet juices to our honey-seeking insect life are decorated with brilliantly con-

trasting colors; many of the fruits prized by man are also distinguished in the same way.

The beginning of the appreciation of the esthetic value in colors may be said to start from the acquirement of colors by the various forms of animal life for the purpose of sex attraction in mating; here the principal reason for the use of color was not especially to attract attention from a distance, but to please by the beauty of the color combination itself; these combinations show a great and beautiful variety when their choice was not restricted by fear of attack on the part of the animals acquiring them, or restricted on the other hand by a life spent mostly in darkness. Animals or insects which are able to live in the air, and consequently do not need concealment from a possible enemy, have developed the brightest and most pleasing color combinations; conversely, those that live in darkness are usually of a dull monotonous color, while those animals requiring concealment usually adopt the colors of their natural environment. Many of the animals of prey show exquisite combinations of color which lend themselves to concealment, as well as beauty. These color harmonies assumed by the various forms of animal life, for the sake of beauty or attractiveness alone, are for the most part very charming, and could not be improved by mankind of the highest state of civilization.

Nature, however, cannot at all times be taken as the standard or ideal for art, in either form or color, but she

does not make many serious mistakes, even in the contrasting colors of flowers, which, as we have already pointed out, were primarily designed to attract attention. The pink color of the rose offers a vivid contrast with very bright green foliage, and Nature, which seemingly is always striving after the true and beautiful, tries to mitigate the sin against harmony in the use of pink and green by toning the rose leaf to a very dark or gray green. Nature also endeavors to make amends for the pink-and-green combination by the wonderful variety of gradations in the pink tints of the rose, than which there could be nothing more to be desired in the beauty of the variety displayed.

Another fact to be taken into consideration is that the color of the rose in its natural sylvan surroundings should not be considered as a part of the general harmonious color scheme, but merely as an accent to emphasize the harmony.

Man being a reasoning animal, as distinguished from the animal world with instinct only, has not developed the instinct for color to its fullest extent, and in consequence the esthetic taste for color has been developed slowly and by educational means. Primitive men, as well as children, have of course the instinctive love for bright colors, being inherited no doubt from the association of bright colors with food; we find this love for bright color exemplified in the colors used by the ancient Egyptians, Assyrians, and many of the present wild

tribes of Indians and Africans. The gaudy colors used by these peoples were due partly to a lack of cultivated taste and not to the fact that the variety of pigment colors they possessed was limited.

With the advance of civilization, a superior esthetic color sense was developed, due to the better educational facilities and larger range of pigments available; for example, the early Japanese produced some very beautiful color schemes which were mostly copied from Nature. Non-esthetic mankind is, however, likely to make mistakes in the use of color schemes from Nature, when selected without due consideration, as in the case of the pink-and-green combination of the rose and rose leaves, a favorite combination with the Japanese, which is essentially a bad combination inasmuch as pure green and pink make a violent contrast, and contrasts are not in themselves beautiful; the Japanese, however, recognized the beauty of the rose and rose leaf, which they failed to analyze; their reasoning could be summed up in the thought that the rose and its green leaves are beautiful, therefore we shall have rose- and green-color combinations. The fact is that the beauty of the rose and its leaves is not due to the contrast of color at all, but in spite of the contrast, the beauty depends on the singularly great variety of tints in the rose color, and on the green leaves being so toned down with gray as to make a near approach to harmony.

The appreciation of the beauty of color harmony is

one of the certain indications of civilization, just as much so as the appreciation of harmony in music indicates the same thing; the child or the savage likes noise pure and simple, as well as bright, contrasting, or gaudy colors, while the great colorists of modern times, as well as the great musicians, love harmony above all things.

To sum up we will find that Nature, when it develops a color scheme with only its esthetic beauty in view, does so invariably in harmonious colors; when contrasting colors are used it is for a purpose aside from beauty alone. Man in his highest development comes to appreciate beauty in harmony in the same way as Nature does, and uses contrasting colors only to accentuate or emphasize a harmonious color scheme, and in the best instances only sparingly even for this purpose. On the other hand, crude, glaring, or contrasting colors are a sign of primitive man, showing a lack of development in color appreciation. Almost any butterfly or bird will give us a beautiful lesson in color harmony, while the ancient Egyptian, the present savage, or the child can scarcely be relied upon for good taste in color.

CHAPTER IX

A FULL PALETTE

IN THEORY the artist should be able to use three primary colors exclusively on a white ground, namely, the minus set, and use them in accordance with the law for the subtractive method. In order to do this, however, the colors (or pigments) would have to be very transparent, and the first applications of color or pigment would have to dry sufficiently so as not to disturb or sully the color over it.

This cannot, however, be realized in practice by the painter as easily as may be done by the three-color-process printer.

The pigments of the painter are not as transparent as the process inks used by the printer, and the painter necessarily applies his pigments much thicker from the brush than is the case in printing. Nor is it so convenient for the painter to allow the colors to dry between their various applications, as is the case with the printer.

In reality we find that, owing to the quality of the pigments, and for the sake of rapidity and directness,

the painter is using the juxtaposit method far more than the subtractive. Therefore the palette should be arranged so as to produce the best results by the juxtaposit method. In theory this would comprise the following pure colors (both plus and minus primaries): red, green, violet, cyan blue, magenta, yellow, white, and black.

The available pigments do not, however, lend themselves to this ideal arrangement. A compromise must be effected by using the best practical pigments that conform most closely to the theory. A good selection would be: Lemon yellow, medium cadmium yellow, English vermilion, cadmium reds, rose or crimson madder, French ultramarine or permanent blue, Prussian blue, emerald green, black, and white

The above colors are necessary, and the following are useful additions: Pale and orange cadmium, yellow ocher, raw sienna, raw umber, light red, Indian red, burnt sienna, burnt umber, brown madder, burnt umber, and terre vert (green)

Black will not be necessary with the "useful additions," as burnt umber and permanent blue, as well as other combinations, make a superior substitute.

Before going into the best methods of mixing these pigments, we will consider a peculiar quality possessed by some pigments, namely, "Dichromatism."

This is the quality possessed by some pigments of reflecting two colors to the eye. This is noticeably the

case with Prussian blue, which will incline towards green in its lighter tints and towards violet in its full hues. A good vermilion will graduate from an orange to a pink in its light tints. All transparent yellows are more or less dichromatic, ranging between orange and green hues of yellow, depending on their thickness or thinness of application.

Pigments with the dichromatic quality are more desirable to mix colors with than non-dichromatic pigments. Conversely, the non-dichromatic pigments are best for the printer or lithographer. Dichromatic pigments will make the most brilliant combinations, but on the press they require more care in order to print the sheets evenly, as slight variations in the amount of color applied will alter the hue on the printed sheet.

After carefully considering the subtractive and juxtaposit methods and their limitations, we naturally conclude that the best method of mixing a hue of color is to start with the nearest pure color and modify it, as required by its nearest neighbor or closely related color in the direction of the proposed modification. This is exemplified in the following partial list:

To mix a yellow green of greatest purity, it will be best to modify emerald green with lemon yellow, or for a blue green modify it with Chinese blue.

It may be said here that emerald green, although our most brilliant green, is somewhat lacking in power (diluted with white), and it inclines a little too much

towards blue. The "spectrum" green is a slightly yellowish green. To make violets and purples we will find permanent blue and rose madder the best, although Chinese blue produces almost as good a result as permanent blue, largely on account of its dichromatism.

We could dispense with permanent blue much more easily than with Prussian blue, permanent blue not being suitable for pure green.

To make an orange it will be obvious that vermilion and an orange yellow will be better than vermilion and lemon yellow. For a true red, vermilion and a little rose madder will be most satisfactory. These mixtures, or the pigments as we buy them, may be altered by the addition of white for tints, or a complementary color for tones, or a black for shades.

In the above we have given no consideration to the qualities of opacity and transparency in pigments, these being so obvious and too well known to need discussion.

We would suggest here to the student or beginner in painting who desires to secure perfect harmony in his work, to limit his palette to the colors shown on the color chart No. 1 for any particular harmony which will accord best with the picture he desires to paint, making only a sparing use of the colors not shown on the chart for mixtures and accents.

Since this chapter was written for the first edition of "The Colorist", the author has had the pleasure of reading the very valuable and instructive books: "Materials

for Permanent Painting", by Dr. Maximilian Toch, and "Artists Pigments" by F. W. Weber—(D. Van Nostrand Company, New York), and in accordance with the information contained therein as to the permanency of pigments, the list of colors for "The Full Palette" in this chapter has been revised as follows:

Permalba, white perfectly permanent under all conditions.
Zinc White.
Ivory Black.
Zinc Yellow.
Cadmiums, Pale, Medium, Deep, Orange, Scarlet, Red, Deep Red.
Yellow Ochre.
Raw Sienna.
Raw Umber.
Burnt Sienna.
Burnt Umber.
Alizarin Crimson.
Vermillion.
Light Red.
Venetian Red.
Indian Red.
Viridian or Emeraude Green.
Terre Verte.
Cobalt Violets.
Permanent Violets.
Permanent Blues—Artificial Ultramarines.

According to the above mentioned authorities, the

above colors are permanent and may be mixed indiscriminately without harmful result.

They have to a great extent, all of the good qualities required in pigments for artists' use.

The principal changes from the list of colors in the first edition, are the substitution of Zinc Yellow for Lemon Yellow, the former being a cheaper and also a reliable color.

The substitution of Viridian for Emerald Green; the hue of Emerald Green can be closely approximated by adding a little Zinc Yellow to the Viridian.

To make the Palette complete, however, we will need two other colors, namely, Alizarin Crimson (which the author suggests in place of Rose Madder, the former being more powerful and much cheaper) and the Prussian Blue —as in the list in the first edition.

Both of these colors are permanent when used alone, or with a certain restricted set of colors from the above list of permanent colors. They may not, however, be used with all of the above colors if absolute permanency is desired, but this need not prevent their use where they are necessary, providing they are used in accordance with the following directions:

The Alizarin Crimson is an artificial Madder-Red (near a Magenta hue), but identical in composition with the natural madder, and is permanent when used alone or with the following colors:

Permalba (white).
Vermillion or Cadmium Red.
Permanent Blue.
Ivory Black.

These are, in fact, the only colors with which the Madder or Alizarin color must necessarily be used. Some very tempting combinations which are permanent may also be made as follows:

Alizarin Crimson, Permalba (white) and Indian Red.
" " " " " Burnt Sienna.
" " " " " Burnt Umber.

(Dr. Toch recommends the use of this color as a glazing color only). There should never be any occasion to use this pigment with a Yellow of any description: adding a pure Yellow to Alizarin Crimson or Rose Madder would produce a color similar to Vermillion,—which requires no substitute. The Alizarin Crimson, or in fact, any Madder Red, should be used only to produce Pinks and Purples, to modify Vermillion towards Purple, and to modify Permanent Blue toward Violet or Purple.

Prussian Blue is essentially *the* blue for landscape greens and sunny skies; it should, in fact, be used for practically nothing else. The following colors may be safely used with Prussian Blue, viz.:

Permalba or Zinc White (but not a Lead White);
Zinc Yellow.
Cadmium Yellows and Reds.
Yellow Ochre.
Raw Sienna.
Raw Umber.
Terra Rosa.
Venetian Red.
Indian Red.

Burnt Sienna.
Burnt Umber.
Permanent Blue.
Ivory Black.

The Prussian Blue may, of course, be mixed with any or all of the above pigments without harm to the permanency of the mixtures.

Upon careful examination it will be found that all of the desirable results may be obtained with these permissable colors.

A new and very desirable pigment has lately been added to the list of artists' colors under the name of Cadmium Red. This color will take the place of and is better than Vermillion for most purposes. This color is very brilliant and has greater tinctorial power.

The author would recommend to every artist and serious art student, a thorough study of Dr. Toch's book and F. W. Weber on "Artists Pigments" on account of the wealth of scientific and practical information contained therein, in reference to the permanency and drying of pigments, the cracking of pigments and varnishes and the prevention thereof, as well as methods of restoring pictures.

CHAPTER X

THE PROPER WAY TO BLEND OIL COLORS FOR CLEAN, LUMINOUS EFFECTS

THE flesh colors in portraits or figures are admittedly hard to paint successfully. One reason may be that the observer is more likely to be well informed as to its appearance, and consequently more than usually critical.

Velasques was eminently successful as a painter of flesh. He probably stands unequaled and in a class by himself in this regard. Of him it has been said: "He dipped his brush in light and air and drew it across the canvas, his genius making a wonder of glowing, yielding, life-like quality of his flesh tones."

Some of the old masters of the Italian school, with their secret (?) method, also painted flesh tones with great skill.

The author does not share the belief that there is any magic or anything out of the reach of the average painter with a thorough knowledge of color in the work of the old masters.

Flesh colors in chiaroscuro contain many colors that

are complementary to each other, such as pink and green, red and blue, etc. These colors, as we know from our consideration of the subtractive and juxtaposit methods, will produce when blended and viewed by reflected light various degraded colors, or colors mixed with gray.

In a painting these colors as pigments must merge into each other, and to be successful or look clean, bright, and glowing, this tendency to produce gray by admixture must be overcome.

On examining the work of some of our best modern painters, it will be noticed that they have not succeeded in entirely overcoming this difficulty.

If we will consider that by the additive method the combination of red and cyan blue produces white, and the combination of green and red produces yellow, while these combinations by the juxtaposit method produce gray and yellow gray respectively, we will have found the key to the solution of the problem.

If in the model red and blue are found blended, they will be blended in the model with rays of light (or the additive method). Therefore, when we imitate the model with paint (by the juxtaposit or the subtractive method), we must imitate the action of light by placing white, the additive combination of the colors, between them, and allow them to blend into the white instead of into each other. For the same reason when we wish to blend red and green, we must place yellow between them as the blending color.

This principle will hold good for the blending of all complementary colors in painting.

A partial list of these blending colors may be shown as follows:

To blend		red and blue (cyan),	use	white.
"	"	red and green,	"	yellow.
"	"	red and violet,	"	magenta.
"	"	yellow and violet,	"	white.
"	"	green and violet,	"	blue (cyan).
"	"	green and magenta,	"	white.

Colors more closely related to each other than the above, or colors within 75 degrees of each other on color chart No. 2, will blend into each other without the tendency to produce gray or muddiness.

CHAPTER XI

COMPLEMENTARY COLORS IN SHADOWS

THE blending of the complementary colors naturally brings to mind the thought of complementary shadows. It is the belief of the author that a careful analysis of the reason for complementary shadows will correct some of the exaggerated notions on this subject held by modern artists.

When we look at a landscape in sunlight, we will observe that the lights are yellow and the shadows are blue with a violet tinge. Sunlight produces the yellow lights, while the blue in the shadows is supplied by diffused light, which is of course tinged with blue from the atmosphere. These shadows are tinged in turn by the nerves of the eye, which call up the complementary of the brilliant sunlight color, which is violet.

The shadows will therefore appear tinged slightly with violet. In trying to represent this effect on canvas, our lights, being a non-luminous pigment and not possessing the power of sunlight, will not call up violet in the eye to a sufficient degree. We must therefore

add violet to the color of the atmosphere in the shadows, in order to successfully simulate the effect of sunlight.

On a "gray day" we do not have the influence of the sun to produce the violet action in the nerves of the eye, as mentioned previously, and the atmosphere, being charged with more moisture, reflects a white or neutral color. We therefore have a different color proposition to deal with. It will be found that on a "gray day" the eye alone is responsible for any complementary colors which may appear in the shadows. Therefore it will be correct to paint a brilliantly colored object with shadows tinted very slightly with its own complementary color, while neutral objects will be best painted neutral in the shadows.

In the studio illuminated with diffused north light, on a clear day the lights partake of the color of the atmosphere and are tinted blue. This dominant light is the one which exerts the greatest influence on the color of the shadows, by calling up its own complementary in the eye. The complementary color of atmosphere blue is an orange red.

A particularly brilliant object will also have an individual effect on the eye, often overbalancing the effect of the dominant blue illumination. For example, if we examine a piece of red woolen goods in such a condition, we will find the lights, owing to the additive addition of the atmospheric blue, to be whiter or inclined to pink. The shadows will appear to be somewhat neutral in

color, owing to the addition of the complementary color (blue) of the goods by the eye. The reflected lights are of course, as always, a lower-toned color of the goods, which in this instance is red.

The foregoing will bring us to the realization that there is no set rule for the complementary color of shadows which will apply under all conditions, and also that the artist, by a proper regard for the scientific principles governing the complementary color shadows, will be better able to render the various effects of strong or dominant illumination or weak and ineffective illumination.

CHAPTER XII

SURFACE TEXTURE IN PAINTING

WHEN we observe a solid object of dead coloring, say a brick, an object that is without gloss, we instinctively feel that our power of vision cannot penetrate the object or go beyond it. We will find by examination that the object has the following properties or qualities which give us this impression, namely, *Granularity of Surface* and *Opacity*. The painter desiring to imitate such a surface will naturally have recourse to an opaque pigment applied so as to have a granular surface. A good example of this would be water-color vermilion, white, and black applied to a rough paper to represent a brick. Suppose we examine a brick house in the distance; we will find the bricks subject to modifications of color, due to the atmosphere and light of illumination, but they still retain their opacity and granularity of surface.

If we place the brick in shadow, we will observe that it has lost its appearance of granularity, but still retains its opacity. Representing it in this condition, the artist

will still use an opaque pigment, but smooth the surface or texture of his pigment, making it partially or dull polished. If we examine a brick thrown into a clear stream of water, we will then see the brick behind a transparent or glossy material which the painter could represent with a glaze or tinted varnish, preferably on a smooth surface.

It will be seen then that we have the following qualities of pigment and of surface to deal with in painting: *Opacity* and *Transparency* of pigment, with *Granular*, *Smooth*, *Polished*, or *Glossy* surfaces.

The pigments may be conveniently divided into Opaque, Semi-opaque, Translucent, and Transparent.

Many otherwise excellent oil paintings have what may be called a "painty" appearance, due partially to the lack of granularity of surface and juxtaposed coloring. (Juxtaposed coloring is considered in the next chapter.) Water-color paintings as a rule have more atmosphere, or a lack of "paintiness," owing to their granularity of surface. That this paintiness is not an inherent fault or quality of oil paintings is readily seen by examining the work of Whistler and some other eminent artists. Whistler took great interest in, and pains with, the surface texture of his oil paintings, applying thereto a keen appreciation and more than usual knowledge.

The application of the principles governing the manipulation and use of surface texture is so obvious that but few remarks need be made on the subject.

Generally speaking, solid or opaque objects when near and well lighted require opaque pigment and granularity of surface. The same in the distance require the granularity of surface, but a semi-opaque or translucent pigment may be employed to show the intervening atmosphere. Opaque objects in shadow will require a smooth or glossy surface, and the range of pigment may be from opaque to transparent, depending on the depth of the shadow. As a rule shadows should be smooth or glossy, while well-lighted objects should have a granular surface.

Semi-opaque or semi-transparent substances, such as flesh in portrait or figure painting, can be well represented by a translucent pigment, or, better still, by a transparent pigment over an opaque ground.

In the same way a distant haze presents a view of distance through a translucent veil or fog, and may be represented on canvas in the same way by scumbling an atmospheric or fog color over objects in the distance painted in nearly normal colors.

CHAPTER XIII

THE PROPER COLORS FOR AERIAL PERSPECTIVE

IT IS a well-known fact that a solid, homogeneous mass of color is not as pleasant to the eye as the same color made up of particles of different colors. This may be tested experimentally with the cards colored red and green, mentioned in the chapter on the juxtaposit method of combining colors, by contrasting the cards with a solid color of the same hue and tone. The juxtaposit mixture of the cards seems to have more life and perhaps more of a luminous and translucent appearance.

A possible explanation for this is that the juxtaposit method gives the eye a more thorough notion of heat and light vibrations than does the solid mass of color. This would suggest that flesh tints could be represented better by the juxtaposit method than by using a solid, homogeneous color.

The application of pigment to canvas by the juxtaposit method has been practised considerably by mod-

ern artists of the impressionist school. Some paintings by Monet, for example, represent luminous atmosphere admirably, even though he used the plus colors to do it with, when the minus colors answer the purpose better.

The best application of the juxtaposit method of placing colors on canvas in pictorial art is undoubtedly their application by this method for painting distance and light or luminosity.

The eye when looking at a distant object is impressed by a large variety of light rays or waves. Therefore when we wish to simulate this effect on canvas, we should adopt all means to impress the eye with the largest variety of light rays or waves.

There are three distinct ways of doing this: First, by using a granular surface, which breaks up the light into brilliant and subdued particles. Second, the use of the juxtaposit method of applying the pigments, which adds to the variety of light rays. Third, the use of the minus set of colors, because they contain two elements of light each, as compared with the plus set, which contain only one ray or element of light each.

While luminosity either near or far is best achieved by a granular surface together with the minus colors applied in juxtaposition, the reverse is the case with shadows and receding effects. In the case of shadows and receding effects, it will be found best to use a smooth surface and transparent pigments applied either sub-

tractively by glazing one over another, or by the juxtaposit method, using at the same time the plus colors on account of the retiring quality they possess through their property of absorbing two elements of light and reflecting but one element.

It is not to be denied that it is far easier to say apply pigments to canvas by the juxtaposit method, than to do so. At the present time there is no satisfactory or easy way for doing this.

The method usually adopted by artists is to laboriously apply the pigments in small touches with a small brush. We might suggest that one way to overcome the difficulty would be to grind the pigments very coarse, so that their separate particles when mixed would be apparent to the eye on close observation. It would be easy to conceive that pigment ground so that its particles were no smaller than bird-shot should, when mixed, produce a beautiful effect when viewed from the proper distance.

A method of juxtaposing pigment on canvas, practised with success by the author, is as follows: A thick coat of opaque pigment of suitable color is first applied evenly to the canvas, then broken up into little elevations and depressions by repeatedly pressing or jabbing the bristle ends of a stiff hog-hair brush into the pigment. This is allowed to dry and then color or pigment may be juxtaposed on it by dragging a sparsely charged brush over it. In this way the last applica-

tion of pigment may be made to cling to the upper surfaces of the little elevations only, presenting a simultaneous view of the two applications of pigment or color.

CHAPTER XIV

ART OR TRUTH IN PAINTING

ACCORDING to the best modern ideas on the subject, pictorial art should be the expression, to a large degree, of the imagination of the artist.

Literal truth in art is unattainable and undesirable. Under the very best conditions paint is sadly limited in its ability to simulate light or luminosity. For example, no artist or painter can give anywhere near an adequate idea of his impression of the sun or moon, even when not at its brightest, and yet we sometimes see attempts of this sort made. It is needless to say that such attempts can result only in failure.

As far as the representation of luminosity is concerned, it would seem best to limit the scope of art to the subjects and effects within reach of the imagination at least.

As the principal concern of art is *beauty*, and as Nature cannot at all times be said to represent the highest type of beauty, therefore it would seem to be within

the province of art to depart from Nature, through the imagination, to a sufficient degree to achieve beauty in both form and color.

The limitations of Nature in the composition of form are well known to artists, and the knowledge is rapidly becoming common property through the medium of the amateur photographer.

The limitations of Nature as to color composition do not seem to be appreciated even by artists as fully as those of form composition. For example, we frequently see in Nature, particularly where there are evidences of civilization, colors which are out of harmony, colors which have a discordant or unpleasant effect on the eye. And it will often be surprising to note what small changes are required in such color compositions to make them harmonious.

For instance, changing the color of a brick house into the various reds, ranging from orange red, red, purple red, and crimson pink, or the changing of the color of the sky into the various violet, gray, or green-blue colors, as required, or changing the color of grass and foliage into the various blue, yellow, and gray greens.

As a matter of fact the same artistic license may be taken with Nature in color composition as is taken in composition of form, and still give the impression of truth as well as of beauty.

CHAPTER XV

A STANDARD COLOR CODE, AND NOMENCLATURE

THE infinite variety of arbitrary names applied to various colors in the commercial and art worlds suggests that it would be a great convenience and economy to so codify the colors as to make it easy to describe them with a fair degree of accuracy, either with words or formula.

At the present time the usage of color nomenclature is so indefinite that the word red may be used to indicate any one of a wide range of colors, including red orange, red, crimson, and purple red, together with their tones of tints and shades. The word blue may indicate any color from a greenish (peacock) blue to a violet, including the various modifications of light and shade. The words yellow, green, orange, and purple, while they each cover a wide range of colors, are more confined to a standard than red and blue. The word violet is used perhaps as often to designate a purple as it is to designate a violet.

Mere rule-of-thumb or empirical methods of deter-

mining the names of colors, which we are sorry to say have been largely used in color text-books for the public schools in America, can only lead to further confusion, and for this reason the author has adhered as closely as possible to the recognized scientific names for colors throughout this book.

The author respectfully submits the following method of elaborating these names, so as to make them applicable to ordinary usage.

For convenience the colors are placed in a circle (see color chart No. 2), somewhat after the manner indicated in the chapter on "Beauty in Color." Beginning with the top, where we place the yellow, and reading to the left, the names of the colors which we would suggest will appear in the following order, 15 degrees apart.

Yellow, lemon yellow, yellow green, sap green, green, bluish green, turquoise blue, greenish cyan, cyan blue, bluish cyan, blue, blue violet, violet, purple violet, purple, purple magenta, magenta, crimson, scarlet, scarlet red, red, orange red, orange, orange yellow.

These names should represent the pure hues (saturated and brilliant) or colors without any black or white mixed with them. The modifications with white may be indicated by using the term *tint* with the name of the color, thus: a tint of red, or a light tint of red, or a very light tint of red.

The darker tones or hues mixed with black may be designated by the use of the term *shade*, thus: a shade

of green, a dark shade of green, or a very dark shade of green.

The broken tones or hues modified by the addition of gray or a complementary color could be represented by using the term *gray* with the name of the hue, thus: a grayish blue, a gray blue, a very gray blue.

The following few examples will serve to illustrate the application of this method of describing colors. It must be remembered, however, that in these examples we are necessarily confined to well-known colors which are well enough described by their own names, and do not need such a method for their description. A pink could be variously described as a tint, a light tint, or a very light tint of either scarlet, crimson, or magenta. A red brown may be a shade, a dark shade, or a very dark shade of scarlet red or red. A yellow brown may be a shade, a dark shade, a very dark shade of orange red, orange, or orange yellow. Or it could be a grayish or gray tone of any one of these colors.

A flesh color could be described as a grayish tint of orange red. Amber could be called a shade of yellow, or gold color a grayish yellow. Sage green might be called a gray green. Navy blue a dark shade of violet.

There is of course a pressing need for an accurate method of description which would enable a correspondent to send an accurate description of a color by mail or telegraph in a simple formula. This may be done in a manner to fulfil all commercial requirements satisfac-

torily, with a color wheel and a set of eight Maxwell discs.

These sets should be made up of the two sets of primary colors, the plus and the minus colors, together with a black disc and a white disc. The wheel should have 100 divisions at the outer edge, so as to enable the percentage of each color to be taken. The colors should be mixed as indicated in the chapter on "A Full Palette," by combining in each instance only a plus color and a minus color, and these colors should be not more than 75 degrees apart on the color chart No. 2. These two primaries may be modified by the addition of black and white, or both.

Using the chemical form of notation to indicate the results of combinations on the color wheel, we may represent vermilion, possibly, by the formula R. 85, Y. 15, substituting the initial letter for the complete word (as red 85, yellow 15).

Emerald green may possibly be represented as G. 80, B. 10, W. 10 (green 80, blue 10, white 10).

Ultramarine blue as V. 85, B. 15 (violet 85, blue 15).

Prussian blue as B. 75, V. 15, D. 10 (blue 75, violet 15, and dark or black 10).

It will be noticed that the initial letter B. occurs in both blue and black; we have therefore substituted D. for the initial letter of black, making it read dark instead of black.

The initial letters will therefore read as follows for

the eight discs: Yellow, Y.; green, G.; cyan blue, B.; violet, V.; magenta, M.; red, R.; white, W.; and black or dark, D.

The examples above are not from accurate measurements, and only indicate roughly the proper proportions.

It is the purpose of the author to arrange for the manufacture of a color wheel and a set of standard color Maxwell discs of sufficient accuracy to meet the requirements of commerce.

CHAPTER XVI

ADDENDUM

THE application of the theory of color harmony, as formulated in the chapter on "Beauty in Color," has of course the widest possible range, and may be used for every purpose with which beautiful and tasteful color combinations are concerned.

Naturally one of these applications of the theory would be in the selection of colors for ladies' costumes.

The following are examples of the twelve principal harmonies from short descriptions by Miss M. K. Hatt.

Harmony No. 1, as represented in an evening gown for a brunette, could be made of flowered net having a dull cream-yellow ground upon which dark orange-red flowers and yellow-green leaves are scattered, mingling the gray and shadowy flowers with the more brilliant, Dresden fashion. The net should have an underslip of cream silk, the flounces and ruffles of the net to be piped with yellow-green taffeta, and finished with a yellow-green girdle.

Harmony No. 2 is comprised in a gown for a brunette, made of warm gray chiffon, with an underslip of taffeta, changing in color from a dull yellow to a dull red, the principal trimming being a shirring of the chiffon. The girdle to be a wide ribbon velvet of dull red, with a "chou" at the back.

Harmony No. 3 could be a "border gown," the bodice and skirt as far as the knees being of dark ecru yellow, which melts into the border colors of tan, brown, then dark brown, through which are distributed faint red and pink roses. Brown velvet ribbon and pink roses trim the corsage of the gown.

Harmony No. 4. A color combination for an evening or dinner gown of black moire, showing flower effects of delicate salmon-pink velvet roses.

The seams of the skirt are left open from the knees down, showing an underdress of low-toned red. This red also forms accents at the shoulders and sleeves of the gown.

Harmony No. 5. A beautiful gown could be made of warm gray chiffon satin, on which has been appliquéd, with a silk cord, motifs of orchids cut from the material known as "Toile de Jouy." These would range in color from pink red to low-toned red and gray purple.

The lines of the gown could be accentuated by these.

Harmony No. 6. Could be used in a gown of dark gray-purple chiffon, ornamented with dark violet flowers.

The underdress to be taffeta of a delicate low-toned

pink, which should show slightly through the gray-purple chiffon.

A bunch of dark (velvet) violets, with small ribbons of purple cascading from it, to be placed at the girdle.

Harmony No. 7. Might be made into a pale blue-violet velvet evening gown, with small sequins of dark purple scattered over it.

The gown should have a deep flounce of purple chiffon at the bottom, on which is appliquéd violet motifs of velvet.

Touches of violet could be used to bring out the lines of the corsage.

Harmony No. 8. For a blonde, a black gown of net which shades into pale blue at the bottom would be very becoming.

Through the blue should be scattered profusely violets of a deep tone. Blue and violet chiffon would form the top of the corsage, as well as the sleeves and lower part of the skirt.

This gown should have a black underslip.

Harmony No. 9. These colors suggest a beautiful "empire" gown of blue-green silk mull, through which can be seen a changeable underdress of blue violet and blue.

A narrow Greek border design of dark violet would finish the gown at the bottom, and also be introduced at the high girdle and bands on the short sleeves.

Fillet lace, dyed the blue-violet color, would form the yoke of the gown.

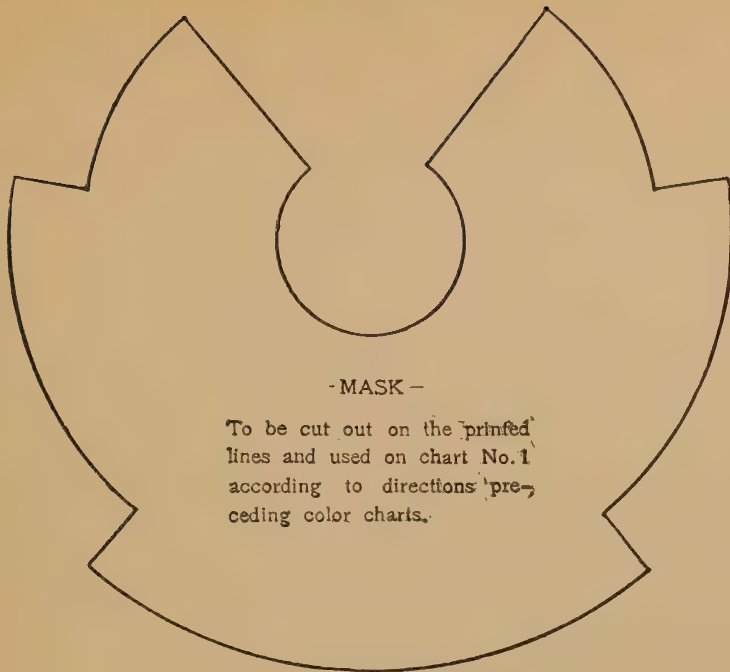
Harmony No. 10. Would be desirable for a delicate sage-green chiffon broadcloth for afternoon wear.

This should be richly embroidered in blue and a more brilliant shade of green, and completed with a soft girdle of cyan blue.

Harmony No. 11. Would be charming for a "Titian" beauty, made up as follows:

A trailing evening gown of mousseline satin in blue green, the top of the corsage having a hand-painted chiffon drapery used as brettels, falling over the shoulders and knotted in a "chou" at the back, the free ends falling to the floor. This would be of grayish green, having greenish-yellow flowers.

Harmony No. 12. Would be suitable for a gown of heavy lace of deep ecru yellow, the only trimming of which would be bands of chiffon satin of an apple-green hue, at the elbows of the short sleeves and at the neck and girdle.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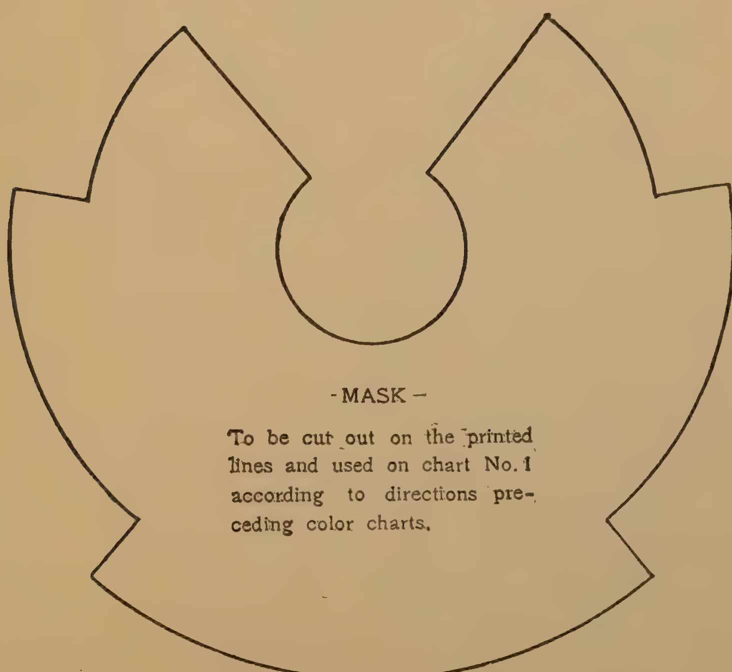
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